

STEPS Students Report

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The aim of the research was to investigate transport properties of carbon nanotubes with different type of conductivity (semiconducting, metallic and mixture). In the laboratory of Prof. Fukuyama I was able to use different equipment for low temperature measurements such as home-made cryostat, Physical Properties Measurement System (PPMS), a variety of electronics. During the internship, I learned a lot new from sample preparations to specific data procession. It was found how to prepare samples in a best way to measure resistance depending on the temperature. To make contacts on thin films of carbon nanotubes the silver glue and copper wires were used. In order to avoid cracks during measurements the parameters of silver pasting were tuned.

On the laboratory facilities it was able to make precise measurements of resistance of samples in wide temperature range (from 300 K down to 1.6 K) and also it was able to conduct measurements in magnetic field (up to 9 T) using PPMS.



During my work in the lab of Prof. Fukuyama we measured transport properties of a set of samples: two types of metallic samples (consistent of arc-discharged single-walled carbon nanotubes (SWCNTs) and SWCNTs of 'Tuball' brand of Russian company OCSiAl with average diameters of 1.4 nm and 1.8 nm

respectively), two types of semiconducting SWCNTs samples and two types of mixture samples (consistent of 30% of metallic and 70% of semiconducting single-walled carbon nanotubes). Also we measured transport properties of SWCNTs doped with copper chloride and double-walled carbon nanotubes doped with sulfur. Most of the measurements were done on the home-made cryostat. Some measurements were also held on the PPMS.

As the results we obtained temperature dependences of resistance of the samples and also current-voltage characteristics were measured. For most samples we obtained variable range hopping (VRH) behavior of conductance. For doped samples we observed Tomonaga-Luttinger behavior of carriers. For single-walled carbon nanotubes doped with copper chloride we observed

power law behavior in transport with Luttinger parameter $\alpha = 0.43$.

Thanks to the STEPS program and hosting of Prof. Fukuyama I gained invaluable experience in the team of highly qualified scientists, received many new knowledge in the field of low temperature physics, nanomaterials and data processing. I was also very glad to meet so many interesting and friendly people and establish scientific and personal contacts.